Efficacy of chemical and cultural practices against covered smut (*Sphacelotheca sorghi*) in sorghum at Abergelle, North Ethiopia

Hintsa Meresa
Dryland Agronomist, Tigray Agricultural Research Institute, Abergelle Agricultural Research Center, P.O. Box 44, Abi-Adi, Ethiopia, Email: hintsa1982@gmail.com
Corresponding author: hintsa1982@gmail.com ,phone: 0914837625

ABSTRACT

Sorghum (Sorghum bicolor L.) is the most important cereal crop grown for food and nutritional security. Despite its importance to household livelihoods, its productivity is low due to several biotic and abiotic factors. Amongst them, covered kernel smut is the major pest that resulted in low sorghum yields. Therefore, the study was conducted in the Abergele district during the 2015–2016 cropping season to investigate the effects of cultural methods and fungicides on covered kernel smut (Sphacelotheca sorghi) of sorghum. The treatments consisted of four factors (Apron star, cattle urine, hot water, and pure water (control) with three replications. The experiments were a randomized complet block design (RCBD) with three replications. The results of the analysis of variance revealed that there was a significant ($p \leq 0.05$) difference for PL, BY, GY, DS (%), DI (%), YL(%), YLR (%), and HI (%), but there was no difference between the treatments for DE 50%, DM 50%, and PH. The highest yields were obtained from Apron star (2,978 kg/ha) and cow urine (2,711 kg/ha) and the lowest (1,944 kg/ha) was recorded from pure water or control. Furthermore, plots treated with Apron star and cow urine had the lowest disease incidence (3.13%) and (4.03%), respectively. Also, the lowest disease severity (1%) and (1.33%) were scored from the same treatments in order, while the highest incidence (29.77%) and severity (3%) were recorded from control. Due to this, the lowest yield loss and highest yield loss reduction were recorded from seeds treated with Apron star and cow urine, while, the highest yield loss percentage (36.6%) was recorded from untreated check. This study suggests that treating sorghum seed with Apron star and cow urine could be equally effective to control kernel cover smut on sorghum. However, cow urine has more advantages over the Apron star chemical fungicide in terms of availability, cost and ecological feasibility, and it cloud be recommended to manage covered kernel smut. The experiment is suggested to be repeated over a year to verify efficacy and rate.

Keywords: Covered kernel smut, Apron star, Cultural practice, Sorghum bicolor

INTRODUCTION

Sorghum(*Sorghum bicolor*) is the fifth most important cereal crop in the world (Huang, 2018). Globally, the mean annual production is 63.89 million tons (USDA, 2017). With an average yearly production of more than 25.6 million tons and a greater land area than the other continents, Africa has emerged as the world's top producer of sorghum (USDA, 2017). According to Gebeyehu *et al*. (2019), Sorghum is now the second-most significant cereal grain in Africa in terms of quantity.

Sorghum is known as one main food crops in Ethioia. It is the primary crop grown in many areas of the Tigray region. The majority of its growth occurs between the lowlands (<1600 m.a.s.l.) and the intermediate (<1900 m.a.s.l.) regions, which receive an annual rainfall of <600 and >1000 mm, respectively Brehane, 1981).

It is the third most important cereal crop in Ethiopia, after tef (Eragrostis tef) and maize (Zea mays) in terms of both area coverage and production volume (CSA, 2015). The growth of this crop is hampered by a number of production obstacles, including as illnesses and insect infestations. Among these, illness is one of the primary factors that inhibits its development. Smut is a common panicle disease that dramatically lowers sorghum yields, especially for small-scale sorghum producers. Sporisorium sorghi is the causative agent of this illness. Disease is a major obstacle that keeps it from being created among them. Smut, a common panicle disease, drastically lowers yiels, especially for small-scale sorghum growers.

There are many diseases those attack sorghum globally,but the most destructive disease of sorghum is smut disease specially covered kernel smut (Reddy et al.,2007). Among the major fungal diseases that cause panicle infection include covered kernel smut which is caused by (*Sphacelotheca* sorghi) (syn. Sporisoriumsorghi).It's the maseare disease in Abergelle Yechila as we opserved in the last coknsucetive yeas at the sorghum growing areas in cluding in the improved variety of Cherie.

Though it appears effective, most Ethiopian subsistence farmers cannot afford synthetic seed treatment chemicals; instead, they are searching for alternative, locally accessible management options (Aschalew et al., 2012; Swami and Alane, 2013; Samuel et al., 2014). Therefore, the use of cultural practices is crucial not only because of its affordability but also because of its less damage to the environment. However, it appears little practical in use in the Tigray region even throughout the country. Nonetheless, this unexplored method offers a lot of promise and potential in cultural practice for resource-poor farmers in Ethiopia and elsewhere, given human and environmental safety as well as its easy accessibility (Aschalew et al., 2012; Samuel et al., 2014). Thus, this study was conducted in Abergelle, central Tigrai to determine the effectiveness of several traditional practices against covered kernel smut brought on by *Sphacelotheca sorghi*.

MATERIALS AND METHODS

Description of the Study Area

The field experiment was conducted at Abergelle Yechila (13°14'06" N, 38°58'50" E; 1500 m.a.s.l) during the 2015 and 2016 main cropping seasons to determine the main factor limiting sorghum yield and quality production: covered smut. It's one of the potentioal areas for sorghum prodcution in Tigray Region.The district has, warm sub-moist lowland (SMl-4b) ,Temperature fluctuations between 18 and 42 degrees Celsius are experienced annually, along with 350 to 700 mm of rainfall (Legesse, 1999).

Treatments and experimental design

The experiment consists of four treatments including two cultural practices, one chemical and control. To assess the treatments' effectiveness against the smut pathogen, seeds of the Charie sorghum variety that was collected from farmer's field was artificially inoculated with *Sphacelotheca sorghi* teliospores. 24 g of spore per 12 kg of sorghum seed was used as stated by Nigusie and Ademe (2020). In a paper bag, the seeds and spores were well mixed before being set aside for one hour to inoculate evenly (Nigusie and Ademe, 2020). The infected seeds were treated with cow urine (fermented at 20 ml/200 g for 30 minutes), hot water (soaking the seeds for five minutes), and an apron star (dressed at a rate of 10 g/kg). the control group (untreated seed) and the hot water boiling for 15 minutes.

Eight rows and a plot size of 6 m * 5 m were employed in three replications of a randomized complete block design. The distances between replications, plots, rows, and plants were 1 m, 0.5

m, 0.75 m, and 0.2 m, respectively. For the experiment, the recommended amounts of phosphorus (46 kg/ha) and nitrogen (46 kg/ha) were utilized. Half of nitrogen was applied at sowing time and the remaining half was applied thirty to forty-five days after sowing. Fertilizer containing phosphorus was applied at the time of seeding. All agronomic practices, including ridging, weeding, and thinning, harvesting, and threshing were done by hand.

Collected Data

Phenological and Growth Data

Days to 50% emergence:- The emergence was recorded 50% by counting the number of days required for seedlings to emerge above the soil surface from the total expected.

Days to 50% physiological Maturity:- Days to physiological maturity were recorded by counting the number of days starting from the planting date to the date when more than 50% of the plants were physiologically matured.

Plant height(m):-Was measerd from the base of stem to the highest part of the plant.

Disease measurement parameters

Throughout the experimental periods, data on disease incidence and severity were recorded. For every plant in the net plot, the incidence was recorded. Plants exhibiting this disease symptoms were counted, and using the following calculation disease incidence was calculated (I):

$$DI(\%) = \frac{\text{Number of infected plant}}{\text{Total number of plants assessed}} X100$$ --Equation 1

Smut severity was recorded on the nine tagged plants using the severity rating scale proposed by Gwary et al. (2001).The scoring scale was :0= No infection, 0 to 15% infected florets = 1, 16-20% infected florets = 2, 21-29% infected florets = 3, 30-45% infected florets = 4, 46–75 infected florets = 5, and 75% infected florets = 6, 41-50% leave area covered with lesion = 7, 50-75% leave area covered with lesion = 8, and > 75% leave area covered with lesion = 9. The following formula was used to calculate the mean % severity.

DS=Σn x 100/N x 9 --Equation 2

Note that, Σn = Summation of individual rating: N = Total number of plants assessed times the highest score: 9 = The highest score on the rating scale.

Yield and yield components

*Actual total grain yield***:**

AdjGY (kg) = (100-AcMc) x AcGy (kg) ---Equation 3

(100-13.5%Mc)

Where: AdjGY (kg) =Adjusted grain yield weight in kilogram per plot

AcMc= Actual moisture content

AcGY (kg) =Actual grain yield weight in kilogram per plot measured immediately after threshing.

After the yield was obtained per plot for each treatment, it was converted to yield per hectare by using the following formula:

Yield per hectare (kg) = $\frac{Actual\ yield\ (Kg)*10000m^2}{Actual\ plot\ area\ (m)^2}$ -------------------------------------Equation 4

Biomass yield:-Measuring after full drying and having constant weight

Harvest Index(HI):-Is the ratio of grain yield to total biomass yield x100.

Assessment of Relative Yield Loss

The following formula was used to get the relative yield loss percentage. The initial yield differential for each seed treatment method was computed by deducting the maximum yield achieved from the yield of plots sown with seeds treated with alternative seed treatment procedures. Consequently, the following formula—which Robert and James (1991) utilized—was used to calculate the percentage of yield loss for each treatment:

The formula for the relative yield loss (%):

$RYL(\%) = \Sigma n\, x \frac{ybt-ylt}{ybt} * 100$ **---Equation 5**

Where:

Ybt is the yield of best treatment or maximum protected plot (seeds treated with Apron star) and Ylt is the yield of lower treatments (seeds treated with other seed treatments).

Loss reduction percentage (%)

The percentage of yield loss reduction was calculatedby subtracting the yield loss of treated plots (YLT) from the yield loss in control plots (YLC) and dividing the difference by the yield loss in control plots (YLC):

$$YLR\% = \frac{YLC-YLT}{YLC} * 100$$ -- Equation 6

Where, YLR% - Yield loss reduction percentage.

YLC-yield loss on the control plot.

YLT = loss of yield from treatment

Data Analysis

Microsoft Excel 2007 was used to calculate and prepare all of the required parameters data. The two year combained data analysis was performed using GenStat 16th Edition statistics software (citation). Mean separation was carried out using the Least Significant Difference (LSD) L at a 5% significant level, following the methodology outlined in Gomez and Gomez (1984).. Correlation coefficients were calculated to determine the relationships between yield and disease data parameters.

RESULTS AND DISCUSSION

Effect of different seed treatments on sorghum phenology

An investigation of the days to emergence and days to 50% maturity in Charie variety using analysis of variance (ANOVA) revealed that there was no significant ($p \leq 0.05$) difference between treatments (Fig. 1). This implies that the phenology of sorghum wa less affected by the seed treatments.

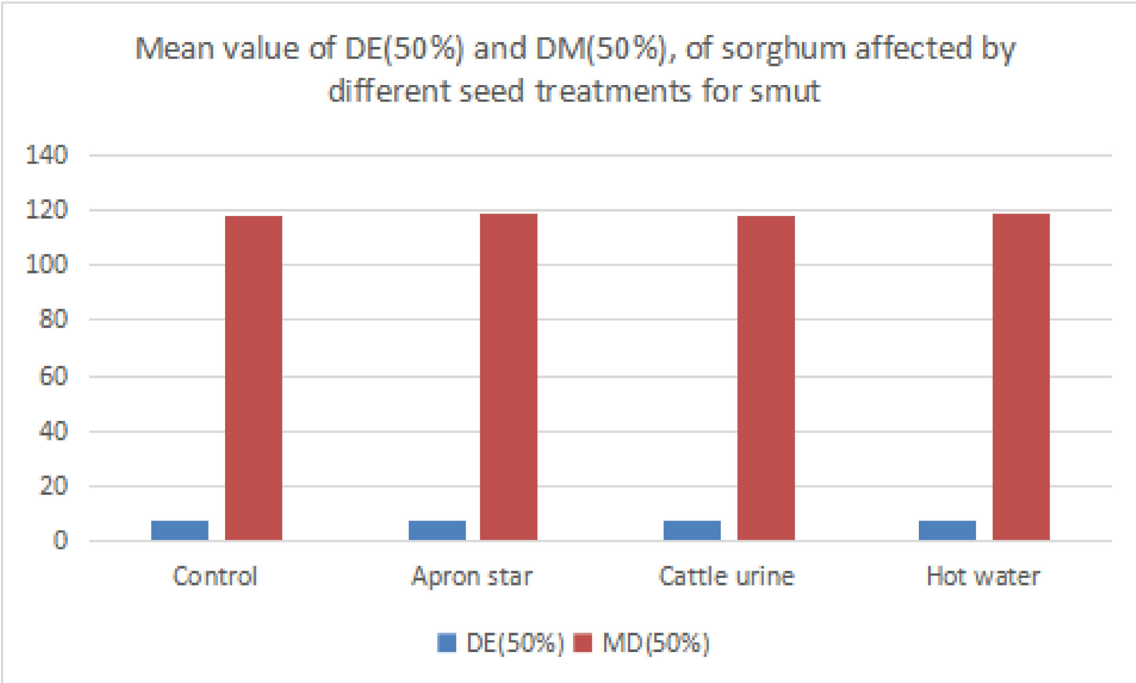

Fig 1: The effect of different seed treatments on Sorghum covered smut.

The effect of seed treatments on sorghum growth

The results of the analysis of variance (ANOVA) indicated that there was no significant ($p \leq 0.05$) difference in plant height between treatments for the Charie variety as indicated in Figure (2)..The seed treatments didn't show difference among treatment in plant height similar to , phenology parameters.

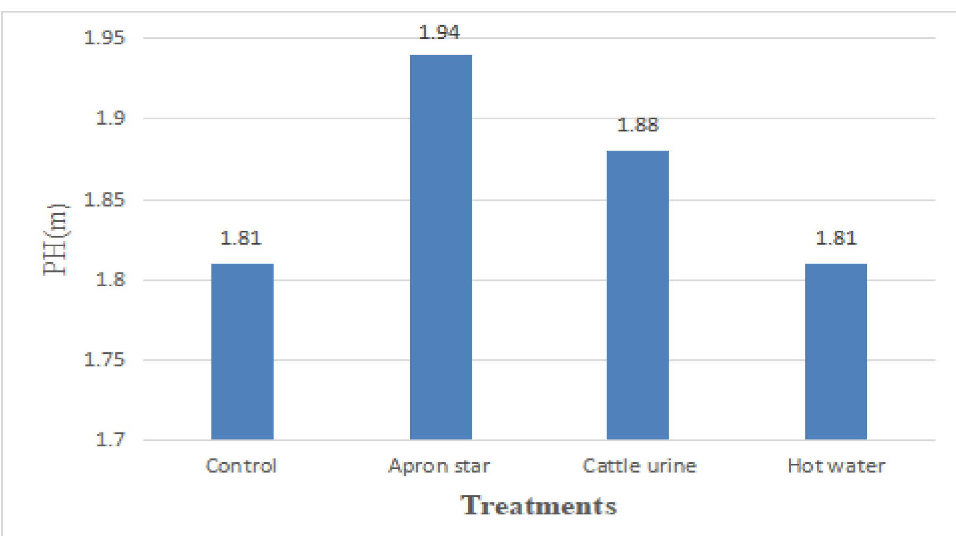

Fig 2: Sorghum plant height as influenced by different seed treatments

Effect of Seed Treatments on the Incidence and Severity of Sorghum Covered Kernel Smut

The results of the analysis of variance revealed as significant difference ($p<0.05$) in disease incidence and severity of covered kernel smut among the treatments (Table 1). The highst disease incidence (29.77%) and severity (3%) of smut infection were recorded in the control plots, whereas the seeds treated with Apron star and cow urine had the lowest recorded infection rates. Specifically, the lowest disease incidence was recorded for plots with seeds treated with Apron star (3.13%) and fermented cow urine (4.03%). Similarly, these treatments also resulted in significantly reduced severity, with Apron Star showing a severity of 1.00% and cow urine-treated plots recording 1.33%. The findings align with the previous studies such as Gwary et al. (2007), who reported that the least amount of covered kernel smut incidence and severity. They observed that the highest incidence and severity of covered kernel smut on the plants from untreated seeds, whereas the plants grown from Apron star-treated seeds plots had the lowest incidence.

The treatments Apron star and cow urine had significantly contributed to lowering the incidence and intensity of covered kernel smut and improving crop yield, which increased yield by -- (Table 1) as compared to untreated and hot water treatments. Samuel et al. (2014) found that the effectiveness of cow urine and botanical Abyie (*Maesalanceolata)* against covered kernel smut using the standard Apron star and control check. They discovered that both treatments were just as effective in controlling the disease. Additionally, the researchers talked about how these readily available materials from the area could be utilized to manage sorghum-coated kernel smut instead of using the chemical fungicide Apron Star.

Table 1: Average mean percentage of incidence and severity of sorghum covered kernel smut in artificial inoculated Sorghum seed

Treatment	DI (%)	DS (%)
Control	29.77[a]	3[a]
Apron star	3.13[c]	1[c]
Cattle urine	4.03[c]	1.33[c]
Hot water	24.88[b]	2.32[b]
LSD (0.05)	2.2	0.77
CV (%)	7.6	21

The effect of seed treatment on sorghum yield and yield components

The results of the analysis of variance (ANOVA) indicated a significant difference ($p < 0.05$) among the treatments in the harvest index, biomass yield, grain yield, yield loss percentage, and panicle length (Table 2). Plots treated with Apron star produced the highest plant length (24.9 cm), biomass yield (2700 kg/ha), grain yield (2978 kg/ha), and harvest index (0.52%) while the control group, which was treated with pure water, had the lowest recorded value for all these parameters. Similarly, seeds treatedwith cow-urine showed lower yield loss, higher grain yield, biomass yield, harvest index, and panicle length compared to the control with untreated seeds. The cow-urine-treated plots demonstrated improved performance across most yield components, including panicle length, grain yield, a reduction in yield loss, and a higher harvest index.

On the other hand, the control plots had the highest yield loss (36.6%), the lowest grain yield (1944 kg ha1) and the lowest harvest index (0.34%). This suggests that an imbalance in the host tissue's physiology caused by the pathogen during the infection and growth phase may be the cause of the yield reduction on plots with untreated seeds.

Table 2. Mean values of yield, yield components, yield loss (%) and yield loss reduction (%) as treatment effect on covered sorghum smut

Treatment	PL (cm)	BY (qt/ha)	GY (qt/h)	YL (%)	YLR (%)	HI (%)
Control	22.5 [b]	5,666[a]	1,944[b]	36.6[a]	9[b]	0.343 [c]
Apron star	24.9 [a]	5,700[a]	2,978[a]	2.9[c]	92.8[a]	0.52 [a]
Cattle urine	23.53 [a]	5.000[b]	2,711[a]	11.6[b]	71.2[a]	0.54 [a]
Hot water	23.47 [ab]	5.311[a]	2,167[b]	29.3[a]	27[b]	0.41 [b]
LSD (0.05)	1.32	484	278.9	9.09	22.6	0.048
CV (%)	3	4.7	6	24	24	5

PL=Panicle length, BY=Biomass yield, =GY=Grain yield=Yield loss, YLR=Yield loss reduction, HI=Harvest index, LSD=List of significant difference-=Coefficient of variation

This outcome was consistent with research by Bdliya et al. (2010), who discovered that seed treated with Apron star 42WS and foliarly applied emulsified neem seed oil had a considerably decreased incidence and severity of covered kernel smut compared to plots sown with untreated seeds.

Additionally, the researchers suggested that covering kernel smut pathogens with Apron star seed treatment may have decreased early infection, improved grain output, and contributed to the decrease in disease and increase in productivity.

These findings are consistent with Sundaram (1980), who identified that in the absence of preventative measures, covered kernel smut is the most dangerous disease. According to Samuel et al. (2014), the disease had a significant impact on the plants in the control plots, resulting in a poor yield or limited normal seeds from all of the florets changing into smut sori.

Based on the available data, the yield loss reduction percentages were recorded from seeds treated with Apron star and cow urine and the minimal yield loss from these treatments was recorded alongside improved grain yields. When compared to the other treatments, the plots sown with untreated seeds performed worse in every parameter, with the exception of biomass yield. According to Selvaraj (1980) and Sundaram (1980), untreated seeds are highly susceptible to covered kernel smut, making it a severe disease that can cause significant yield loss.

Association between disease and yield data

The yield and disease incidence scores obtained from the various seed treatment showed a strong negative correlation (r = -0.9421). As shown in Table (3), there was also a strong negative correlation (r = -0.9321) between the mean severity and grain yield. This suggests that seed treatmented with cow urine and fungicide effectiveness against this disease. On the other hand, the crop's grain yield was significantly negatively impacted by the disease's recorded values.

The result in (Table 3) shows that the yield loss percentage exhibited a negative association (r = -0.99) with yield but a strong positive correlation (r = 0.9421) with severity (r = 0.9321) and incidence (r = 0.9321). In contrast, there was a strong negative connection (r = 0.9421) between yield loss reduction percentage and severity (r = -0.9321). The yield loss reduction percentage showed a strong positive correlation (r = 0.99) with the yield.

Table :3 Association between yield and other sorghum cover kernel smut data

DI (%)	1				
DS (%)	0.9039**	1			
Gy_kg_ha	-0.9421**	-0.9321**	1		
YLR (%)	-0.9421**	-0.9321**	0.99**	1	
YL (%)	0.9421**	0.9321**	-0.99**	-0.99**	1
	DI (%)	**DS (%)**	**GY kg ha**	**YLR (%)**	**YL (%)**

This suggests that the seed treatment techniques against this disease and increases the grain yield, but the covered kernel smut significantly reduce yield. Consequently, an approach to seed treatment that boosts yield. It follows that seed treatments and grain yield were positively correlated.

CONCLUSION AND RECOMMENDATION

The results demonstrated that the fungicide and cow urine significantly differed in their ability to suppress the incidence of Sorghum covered kernel smut. Compared to the untreated seeds, which exhibited the highest disease incidence (29.77%), severity (3%), and 36.6% yield loss, plants grown from sorghum seeds treated with Apron star and cow urine produced significantly higher grain yields 2978 kg/ha and 2711 kg/ha, respectively. Although numerous studies conducted in Ethiopia have showed the effectiveness of these seed treatments, thier application to manage sorghum-covered kernel smut and boost productivity and production efficiently. Plots planted with cow urine and Apron star-treated seeds achieved the maximum yield and and the highest yield loss reduction percentage during the trial.While Apron Star and fermented cow urine is effective to mitigate covered kernel smut infection, cow urine-treated seed can also reduce production costs and boost yields of sorghum by replacing costly fungicides. Furthermore, these materials for treating seeds significantly lessen pollution in the environment. Additionally, using cow urine for seed treatment contributes to reducing environmental pollution, making it a sustainable approach for improving sorghum production.

Therefore, the best ways and ones that may provide substantial farmers with sustainable production and productivity are the use of cow urine as seed treatments against *Sphacelotheca sorghi*. Therefore, farmers in Abergelle and other areas with comparable sorghum-growing regions can apply affordable, environmentally safe, readily available, and efficient seed treatments made from fermented cow urine. However further study may need over location and determine optimal dosage against this disease.

Declarations

Ethics approval and consent to participate: Both are agreed

Consent for publication: Both are deciding on publication.

Data availability statement: All data generated or analyzed during this study are included in this manuscript.

Competing Interest: The author declare no competing interest.

Funding Statement: This study is supported by the Tigray Agricultural Research Institute.

Author contributions: Hintsa Meresa designed the study, collected data, analyzed the data, drafted the manuscript; and full write up of the manuscript. The author has checked and agreed on the final manuscript.

References

Nigusie & Ademe, Cogent Food & Agriculture (2020), 6 1745132https://doi.org/10.1080/23311932.2020.1745132

Aschalew S, Fekede A,Kedir W (2012). Evaluation of three potential botanicals against sorghum covers kernel smut (*Sphacelotheca sorghi*) at Bako, West Oromia, Ethiopia. Afr.J. Plant Sci. 6(8): 226-231.

Bdliya BS, KoloAK, Anaso AB (2010). Efficacy of integrating seed treatment with Apron star 42 WS and foliar application of emulsified neem (Azadirachtaindica, A. Juss) seed oil on the management of covered and long smuts of sorghum (Sorghum bicolor L. Moench) in the Sudan Savanna of Nigeria.Archiv. Phytopathol. and Plant Prot. 43(3): 225-232.

Brehane G (1981). Solient features of sorghum breeding strategies used in Ethiopia. Ethiopian J. Agric. Sci. 2: 97-104

Central Statistical Agency (CSA) (2015). Report on area and production of crops: Agricultural sample survey on private peasant holdings of 2014/2015 Meher season. Central Statistic Authority, Addis Ababa, Ethiopia.

Gebeyehu, C, T. Bulti, L. Dagnachew and D. Kebede (2019). Additive main effect and multiplicative interactions (AMMI) and regression analysis in sorghum varieties. Journal of Applied Biosciences,136:13877-86.

Gomez AK, GOMEZ AA (184). Statistical procedure for Agricultural Research,2nd Edition. Wiley International Science Publication. New York.680pp.

Gwary DM,Ali O. Gwary SD (2007). Management of sorghum smuts and Anthracnose using cultivar selection and seed dressing fungicide in maiduguri, Nigeria.Int.J.Agri.Biol.9(2):324-328.

Huang, R.d. (2018). Research progress on plant tolerance to soil salinity and alkalinity in sorghum. Journal of Integrative Agriculture,17:739-46.

Reddy, B., C. Ravinder Reddy, A. S. Alur, K. Reddy and R. Bhubeshkumar.(2007). Improved Production Technologies for Rainy Season Sorghum in Andhra Pradesh Global Theme on Crop Improvement. International Crops Research Institute for the Semi-Arid Tropics. Andhra Pradesh, India. pp. 20.

Robert GD, James HT (1991).A biometrical approach. Principles if statistics, 2nd edition. New York.USA.633PP.

Samuel T, Fuad A, Zeleke L (2014). Evaluation of efficacy of different disease management practices against sorghum-covered kernel smut (*Sphacelotheca sorghi*) at Fedis and Babile, eastern Ethiopia. Research and reviews. J.Agri. Allied Sci.3(1):31-34.

Selvaraj JC (1980). Sorghum Smuts Research and Control in Nigeria. pp. 36-39. In: Sorghum diseases, a world review: Proceedings of the International Workshop on Sorghum Diseases, 11-15 December 1978, ICRISAT, Hyderabad, India, Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Sundaram NV (1980). Importance of Sorghum Smuts in African Countries. pp. 36-39. In: Sorghum diseases, a world review: Proceedings of the International Workshop on Sorghum Diseases, 11-15 December 1978, ICRISAT, Hyderabad, India, Patancheru, Andhra Pradesh 502 324, India: International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Swami CS, Alane SK (2013). Efficiency of some botanicals against seed-born fungi of green gram(Phaseolus aureusroxb). Biosci Discov. 4(1):107-110.

USDA. (2017). World Agricultural Production. World Sorghum area, yield and production. United States Department of Agriculture. USA. PP.29.

Yalew, D., Dejene, M., and Tegegne, G. 2019. Efficacies of Some Botanicals Against Covered Kernel Smut [*Sphacelotheca Sorghi* (Link) Clinton] of Sorghum [*Sorghum bicolor* (L .) Moench] at Sheraro , Northwestern Tigray , Northern. 5(4), 11–24.

Apendex Table 1: Analysis of variance

Variate: PH					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	0.03128	0.01043	0.47	0.713
Residual	8	0.17864	0.02233		
Total	11	0.20992			

Variate: Panicle Length					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	10.6933	3.5644	7.23	0.012
Residual	8	3.9467	0.4933		
Total	11	14.6400			

Variate: BY_kg_Ha					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	981360.	327120.	4.94	0.031
Residual	8	529491.	66186.		
Total	11	1510850.			

Variate: Gy_kg_ha					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	2047750.	682583.	31.11	<.001
Residual	8	175550.	21944.		
Total	11	2223300.			

Variate: HI_%					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	0.0811746	0.0270582	40.97	<.001
Residual	8	0.0052836	0.0006605		
Total	11	0.0864582			

Variate: Disease incidence					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	1727.986	575.995	414.70	<.001
Residual	8	11.112	1.389		
Total	11	1739.097			
Variate: Disease severity					
Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	7.5833	2.5278	15.17	0.001
Residual	8	1.3333	0.1667		
Total	11	8.9167			